

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. – 10. (Cancelled)

11. (Original) An error control method for multilevel memory cells operating with a variable number of storage levels, the method comprising:

receiving a first information word having k input symbols each in a first base;

converting the first information word into a second base by converting the input symbols into input symbols in the second base;

encoding the converted first information word into a first codeword having $k + n$ coded symbols in the second base;

writing the first codeword into the multilevel memory cells.

12. (Original) The error control method of claim 11, further comprising:

receiving a second information word having k input symbols each in the second base;

encoding the second information word into a second codeword having $k + n$ coded symbols in the second base;

writing the second codeword into the multilevel memory cells.

13. (Original) The error control method of claim 11, further comprising:

reading from the multilevel memory cells the first codeword;

decoding the first codeword into an estimated word having k estimated symbols in the second base; and

converting the estimated word into the first base by converting the estimated symbols into estimated symbols in the first base.

14. (Original) An error control method for multilevel memory cells operating with a variable number of storage levels, the method comprising:

reading from the multilevel memory cells a codeword having $k + n$ coded symbols in a first base;

decoding the codeword into an estimated word having k estimated symbols in the first base; and

converting the estimated word into a second base by converting the estimated symbols into estimated symbols in the second base.

15. (Original) A computer storage device, comprising:

a memory matrix that includes multilevel memory cells capable of storing data in a first base or a second base;

an input transcoder having a word input that receives an information word having k input symbols each in the first base, a control input that receives a control signal indicating whether the memory matrix is operating according to the first base or the second base, and an output that outputs a converted information word in the second base;

an encoder coupled to the output of the input transcoder and structured to encode the converted information word into a codeword having $k + n$ coded symbols in the second base;

a write circuit having an input coupled to the encoder and an output coupled to the memory matrix, the write circuit being structured to write the codeword into the memory matrix.

16. (New) The method of claim 11 wherein the storage levels of the memory cells can assume values of the set $\{b^a, b^{a_1}, \dots, b^{a_1, \dots, a_t}\}$, the first information word is formed by k q -ary symbols belonging to an alphabet containing q different symbols, with $q \in \{b^a, b^{a_1}, \dots, b^{a_1, \dots, a_t}\}$, the first codeword is formed by $k + n$ q -ary symbols, with $q = b^{a_1, \dots, a_t}$, and having an error-correction capacity t , and the encoding step includes generating through an operation of multiplication between the first information word and a generating matrix, the method further comprising:

acquiring values of k , t , b^a , b^{a_1} , \dots , b^{a_1, \dots, a_t} , which constitute design specifications of said first codeword;

calculating, as a function of $q=b^a$, k and t , the minimum value of n such that a Hamming limit is satisfied;

calculating the maximum values \hat{n} and \hat{k} of n and k that satisfy said Hamming limit for $q=b^a$, t and $(\hat{n}-\hat{k})=(n-k)$;

determining, as a function of t , the generating matrix of the first codeword (\hat{n}, \hat{k}) on a finite-element field $GF(b^a)$;

constructing binary polynomial representations of finite-element fields $GF(b^a)$, $GF(b^{a_1})$, ..., $GF(b^{a_1, \dots, a_m})$;

identifying, using said exponential representations, elements of the finite-element field $GF(b^{a_1, \dots, a_m})$ isomorphic to elements of the finite-element fields $GF(b^a)$, $GF(b^{a_1})$, ..., $GF(b^{a_1, \dots, a_m})$;

establishing biunique correspondences between the elements of the finite-element fields $GF(b^a)$, $GF(b^{a_1})$, ..., $GF(b^{a_1, \dots, a_m})$ and the elements of the finite-element field $GF(b^{a_1, \dots, a_m})$ that are isomorphic to them; and

substituting each of a plurality of elements of said generating matrix with a corresponding isomorphic element of the finite-element field $GF(b^{a_1, \dots, a_m})$, thus obtaining a multipurpose generating matrix defining, together with said biunique correspondences, said first codeword.

17. (New) The method of claim 16, in which said first codeword is a linear block code.

18. (New) The method of claim 16, in which the identification of the elements of the finite-element field $GF(b^{a_1, \dots, a_m})$ isomorphic to the elements of the finite-element fields $GF(b^a)$, $GF(b^{a_1})$, ..., $GF(b^{a_1, \dots, a_m})$ is performed on the basis of the multiplicity of said elements in the finite-element field $GF(b^{a_1, \dots, a_m})$.

19. (New) The method of claim 18, in which said step of identifying the elements of the finite-element field $GF(b^{a_1, \dots, a_m})$ isomorphic to the elements of the finite-element fields $GF(b^a)$, $GF(b^{a_1})$, ..., $GF(b^{a_1, \dots, a_m})$ comprises the step of identifying the elements of the

finite-element field $GF(b^{a_1, \dots, a_h})$ that have respectively multiplicity being equal to, or being a function of, $b^{a_1}, b^{a_1 a_2}, \dots, b^{a_1 a_2 \dots a_h}$.

20. (New) The method of claim 16, in which said step of establishing biunique correspondences between the elements of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$ and the elements of the finite-element field $GF(b^{a_1, \dots, a_h})$ isomorphic to them comprises the steps of:

constructing binary polynomial representations of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$; and

establishing biunique correspondences between the elements of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$ and the elements of the finite-element field $GF(b^{a_1, \dots, a_h})$ isomorphic to them, using said binary polynomial representations.

21. (New) The method of claim 20, in which said binary polynomial representations of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$ are constructed using respective primitive polynomials of a degree respectively equal to $a_1, a_1 a_2, \dots, a_1 a_2 \dots a_h$ on the finite-element field $GF(2)$, said binary polynomial representations associating, to each element of the respective finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$, a corresponding binary polynomial of degree respectively less than $a_1, a_1 a_2, \dots, a_1 a_2 \dots a_h$.

22. (New) The method of claim 21, in which said step of establishing biunique correspondences between the elements of the finite-element field $GF(b^{a_1, \dots, a_h})$ and the elements of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$ isomorphic to them comprises the steps of:

for each element of the finite-element field $GF(b^{a_1, \dots, a_h})$ isomorphic with a corresponding element of one of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$, forming a first binary word with the coefficients of the terms of the binary polynomial associated to said element of $GF(b^{a_1, \dots, a_h})$, and a second binary word with the coefficients of the terms of the binary polynomial associated to said corresponding element of one of the finite-element fields $GF(b^{a_1}), GF(b^{a_1 a_2}), \dots, GF(b^{a_1 a_2 \dots a_h})$;

converting said first binary word into the base $b^{a_1 a_2 \dots a_h}$, thus obtaining a first symbol, and said second binary word into the base of the finite-element field to which said corresponding element belongs, thus obtaining a second symbol; said first symbol and said second symbol defining the biunique correspondence between said element of the finite-element field $GF(b^{a_1, \dots, a_h})$ and the corresponding element of one of the finite-element fields $GF(b^{a_1})$, $GF(b^{a_2})$, ..., $GF(b^{a_h})$ isomorphic to it.

23. (New) The method of claim 16, comprising:

determining, for each element of the multipurpose generating matrix, the number of logic gates necessary for carrying out the operation of multiplication associated with said element; and

abbreviating said multipurpose generating matrix to the value of k initially specified, thus minimizing the number of elements of the finite-element field $GF(b^{a_1, \dots, a_h})$ that require the largest number of logic gates.

24. (New) The method of claim 23, in which said step of determining the number of logic gates is performed using said binary polynomial representation of the finite-element field $GF(b^{a_1, \dots, a_h})$.

25. (New) The method of claim 11 wherein the encoding step includes generating the first codeword through an operation of multiplication between the first information word and a generating matrix, the first base is equal to a number of storage levels at which said memory cells operate, and the second base is equal to the maximum number of storage levels of said memory cells, the method further comprising:

decoding a word read in said memory, using said first codeword; and

converting, symbol by symbol, said decoded word from the second base to the first base.

26. (New) A computer storage device, comprising:

a memory matrix of multilevel memory cells operating with a variable number of storage levels;

means for receiving a first information word having k input symbols each in a first base;

means for converting the first information word into a second base by converting the input symbols into input symbols in the second base;

means for encoding the converted first information word into a first codeword having $k + n$ coded symbols in the second base;

means for writing the first codeword into the multilevel memory cells.

27. (New) The device of claim 26, further comprising:

means for receiving a second information word having k input symbols each in the second base; wherein the encoding means includes means for encoding the second information word into a second codeword having $k + n$ coded symbols in the second base, and the writing means includes means for writing the second codeword into the multilevel memory cells.

28. (New) The device of claim 26, further comprising:

means for reading from the multilevel memory cells the first codeword;

means decoding the first codeword into an estimated word having k estimated symbols in the second base; and

means for converting the estimated word into the first base by converting the estimated symbols into estimated symbols in the first base.